

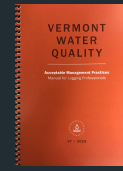
PRIORITIZING AND IMPLEMENTING CLEAN WATER PROJECTS ON STATE LANDS

Dave Wilcox
Watershed Forester





Watershed Forestry Program

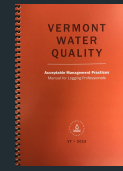


- Bridge Cost Share Program
- Bridge Rental Program
- Education and Outreach





Watershed Forestry Program



- AMP Technical Assistance
- Logger/Forester Education
- Agency Land Tech Assistance



ANR Lands

- 360,000 acres
- 8% of VT land base

Including

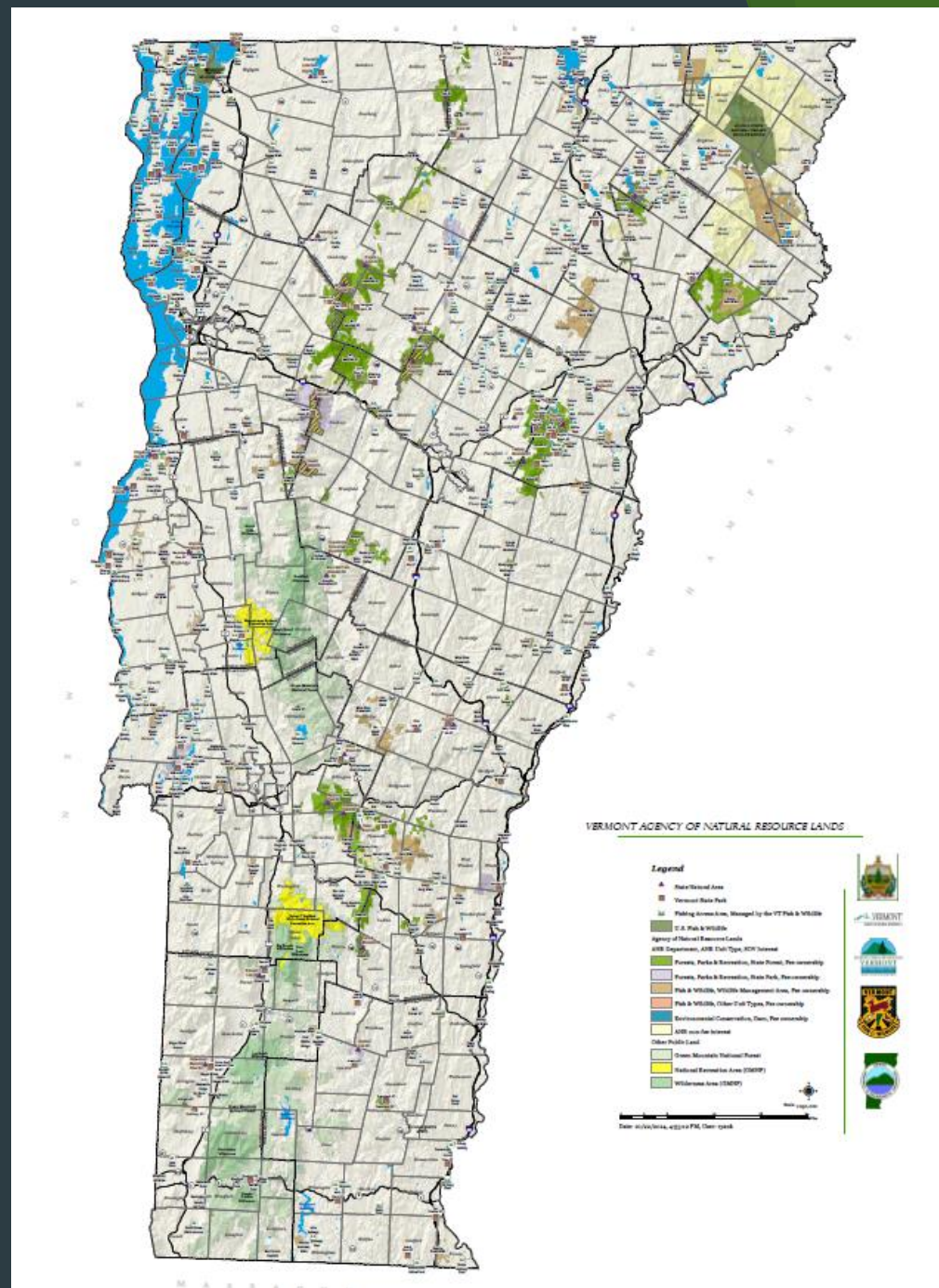
39 State Forests

55 State Parks

80 WMAs

Also, DEC Dam sites, FW Pond sites and
Fishing Accesses

Approximately 600
miles of roads and 1,500
miles of trails



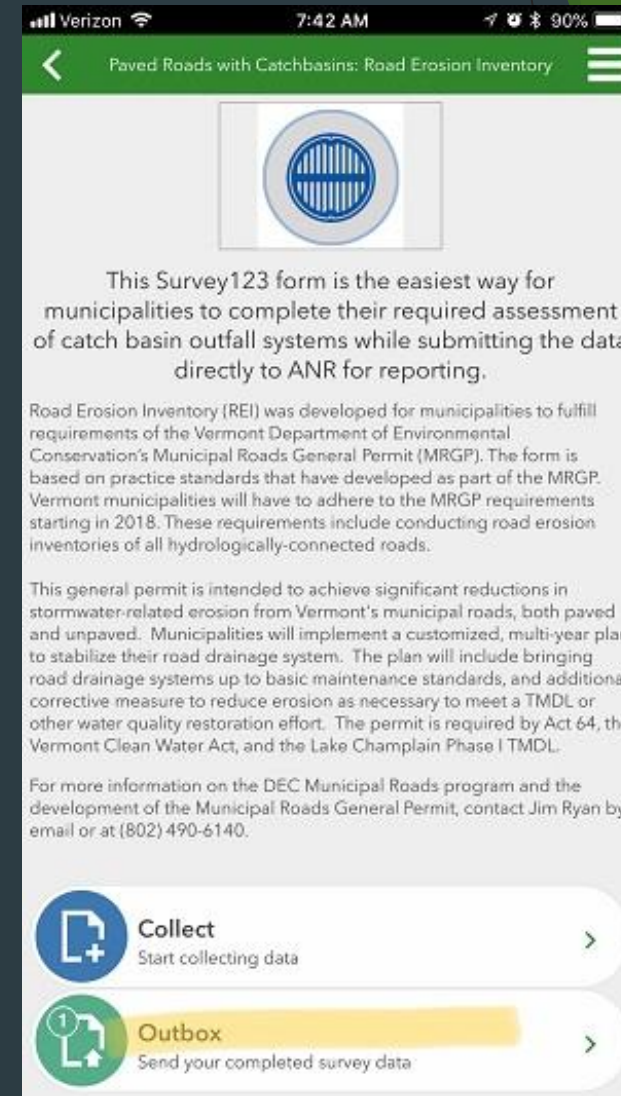
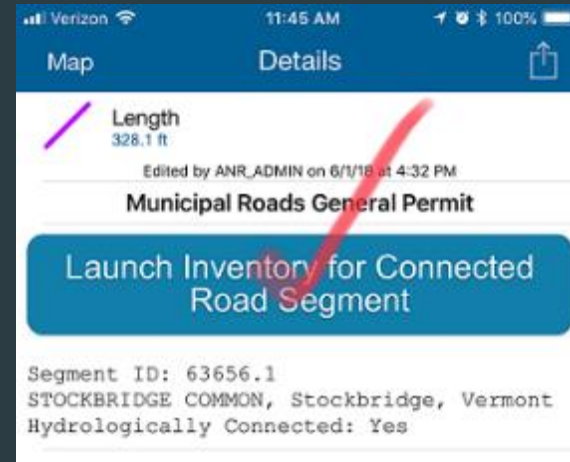
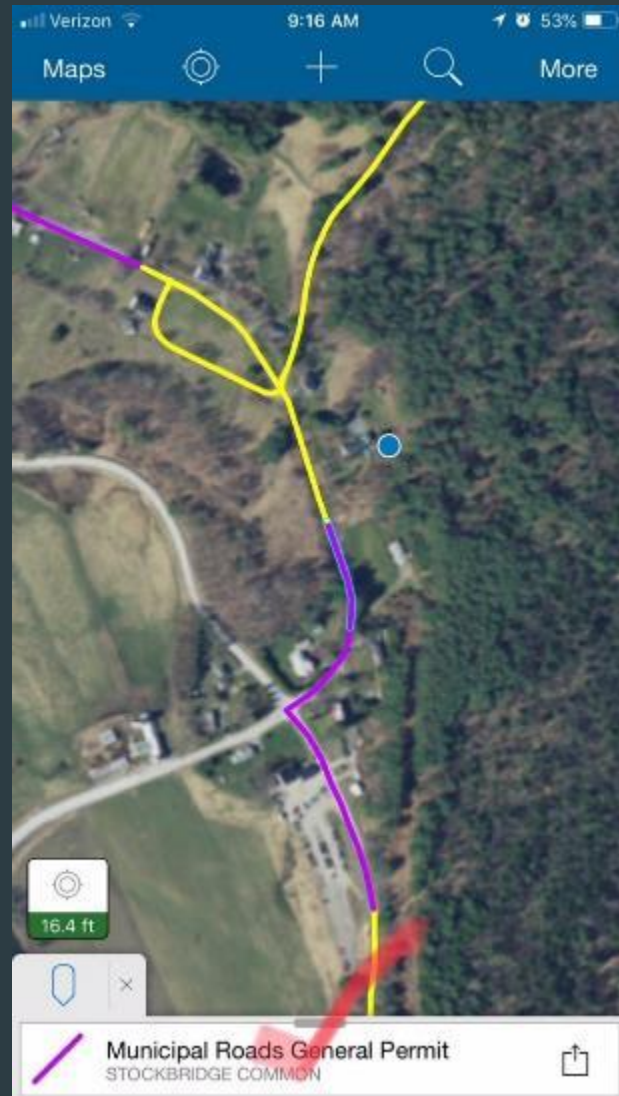
While forestland protects water quality more than any other land use, it is still important to monitor and implement good water quality practices when managing forests for the multitude of uses and benefits they provide.

- ▶ Forest land is estimated to contribute approximately 16% of total phosphorus load to Lake Champlain, primarily coming from the runoff from roads and trails

Previously, FPR applied for ERP (Ecosystem Restoration Program) funds to address erosion issues and sedimentation on State Lands.

- ▶ This was a project-by-project basis.
- ▶ Applications were time consuming and needed lots of details to meet program requirements and standards.
- ▶ In March of 2020, FPR met to begin discussions to create a comprehensive method for assessing roads, determining need, and prioritizing projects.
- ▶ We decided to model our system after the Municipal Road General Permit (MRGP) process.
 - ▶ For forest management roads, the Acceptable Management Practices (AMPs) are used as the standards for the assessment.

MRGP Requirements: Road Erosion Inventory



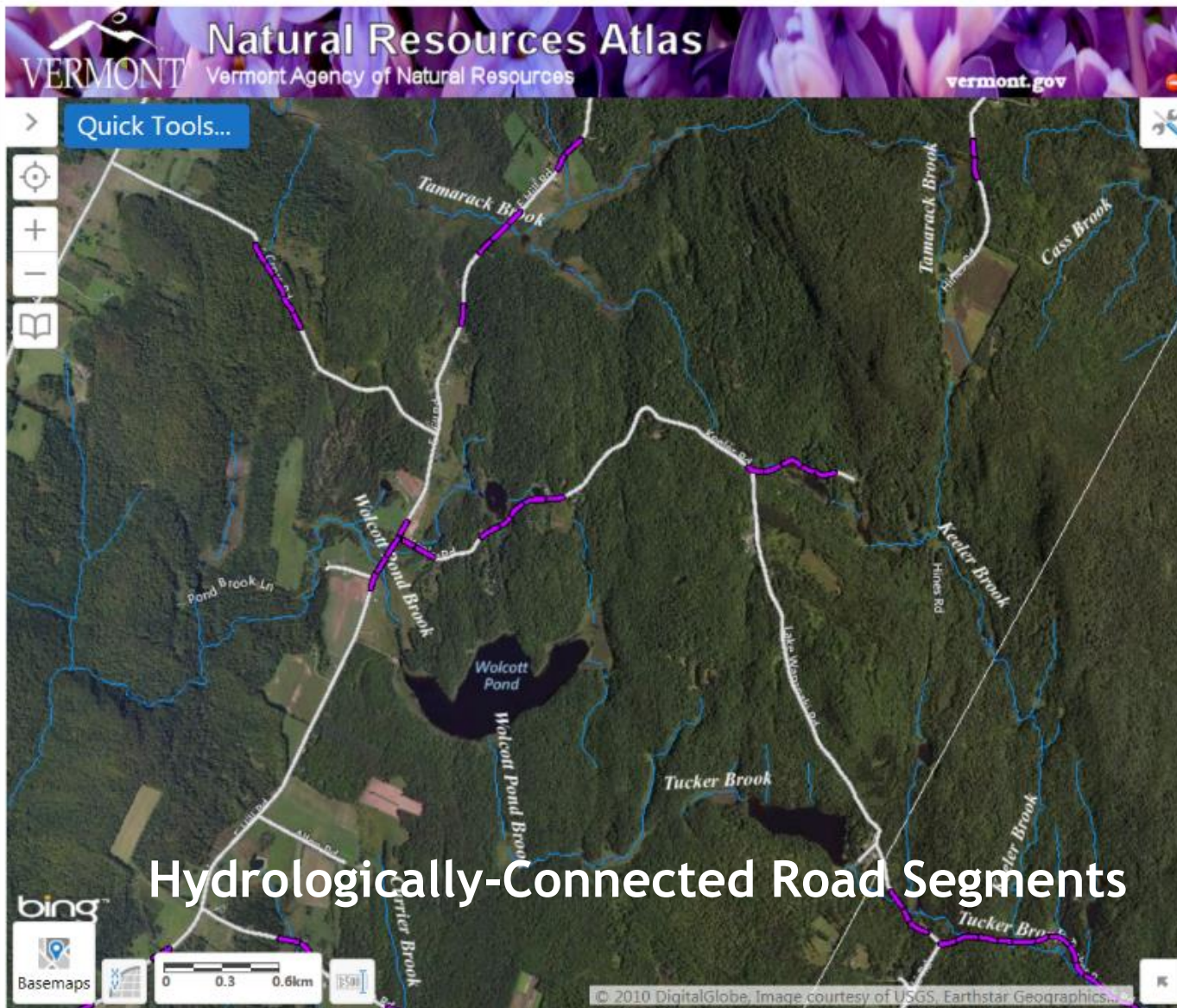
Permitting

Mapping

Resources Atlas

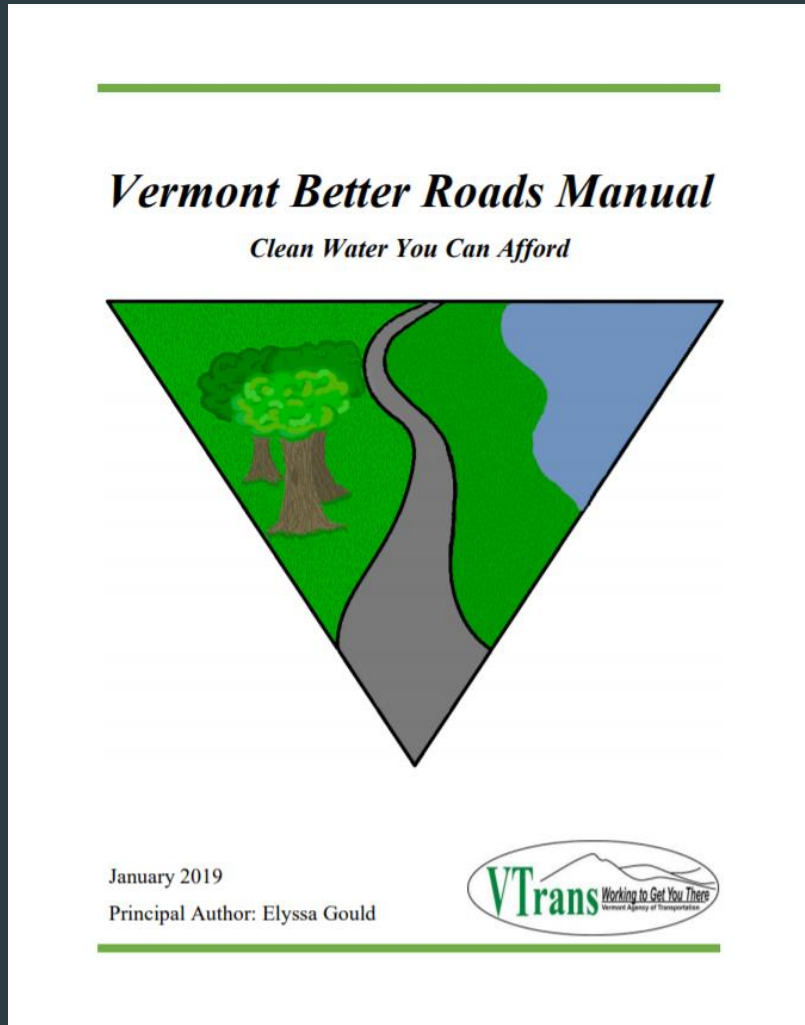
Maps

Environment

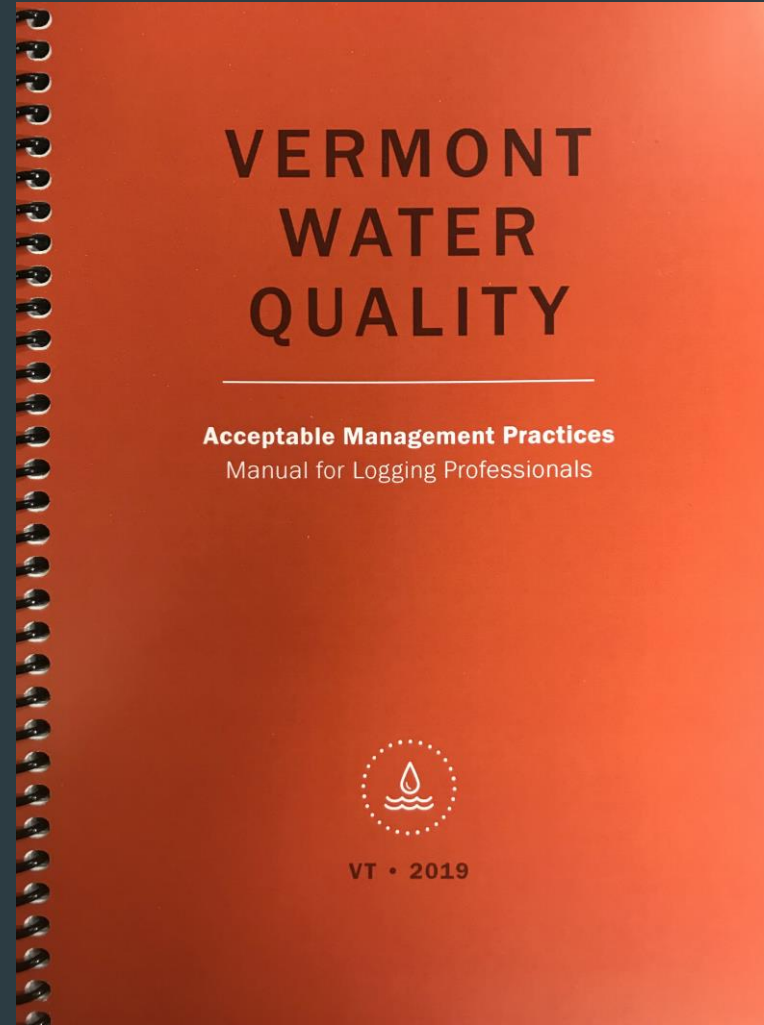


Hydrologically-Connected Road Segments

MRGP



ANR Road Erosion Inventory



What are the AMPs?

26 practices to:

- Protect Water Quality
- Prevent Soil Erosion
- Minimize Stream Impacts


To be applied on:

- Truck Roads
- Skid Trails
- Stream Crossings
- Riparian Areas (Buffers)
- Log Landings

To be applied prior to, during and immediately after harvesting

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AMPs • TRUCK ROADS



CONSTRUCTION
Protecting water quality when building new roads or upgrading old roads is important. Follow these steps to protect the condition of, and investment in, the road.

- Shape roads to move water off the road surface using a crown, an out-slope (this may present a safety hazard in icy conditions or on curves), or an in-slope (this will often require ditches and cross drainage structures).
- Space cross drain culverts according to Table 1, and discharge them into the forest buffer, at least 25 feet from the waterbody.

Drainage structures on permanent and temporary truck roads shall be correctly installed to divert the surface water runoff into road ditches or filter areas. Drainage structures shall be spaced at intervals according to Table 1 where existing soil, rock and ledge conditions allow.


AMP 6.1.2

Water entering a permanent or temporary truck road shall be moved under and away from the road and into a filter area. Culverts used for ditch drainage on truck roads shall be at least 15 inches in diameter, correctly installed to divert ditch water into a filter area and spaced according to Table 1 where existing soil, rock, ledge and road bed conditions allow.


AMP 6.1.3

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AMPs • TRUCK ROADS



- Use gravel, crushed stone, or other surface material (with or without geotextile) to stabilize roads, shed water, and increase the weight-bearing capacity.
- Maintain cut and fill slopes at a natural angle of repose or less (2:1 for average soils) whenever possible.
- As the construction progresses, stabilize areas of exposed soil that will receive road runoff such as cut-and-fill slopes, steep road shoulders, and erosion-prone soils in forest buffers.
- Use temporary sediment barriers to slow flowing water and trap sediment during construction.



Drainage ditches along permanent and temporary truck roads shall not terminate directly into streams or other waters. On approaches to stream crossings, ditches shall be turned out into a filter area a minimum of 25 feet away from the top of bank.

AMP 6.1.4

TABLE 1 Distance (Feet) Between Drainage Structures on Truck Roads and Skid Trails					
Road Grade (% Slope)	Skid Trails		Truck Roads Permanent Truck Roads During & After Logging, Temporary Truck Roads During Logging	Ditch Relief Culverts	Waterbars
	During Logging	After Logging			
1	500	400	500	450	400
2	300	250	300	300	250
5	200	135	180	200	135
10	140	80	140	140	80
15	130	60	---	130	60
20	120	45	---	120	45
25	110	40	---	65	40
30	100	35	---	60	35
40	90	30	---	50	30

TABLE 2A Minimum Culvert Sizing for Stream Crossings Choose the drainage area closest to your crossing site drainage area		
Drainage Area (Acres)	Minimum Diameter for Temporary Culverts <18 mos. (in inches)	Minimum Diameter for Permanent Culverts on Intermittent Streams installed for a period >18 mos. by drainage area (in inches)
4	12	15
8	15	18
16	18	24
20	18	30
40	24	36
50	30	42
80	36	48
120	36	60
160	42	66
200	48	Streams with drainage areas of 160 acres or greater are likely to be perennial. Adhere to the VT VDEC Technical Guidance for Identification of Perennial Streams
320	54	
350	60	
450	66	
640	72	
For Drainage Areas greater than 640 acres, a temporary bridge is required. See table 2B		
* The minimum size for permanent culverts on intermittent streams sh be as outlined above or shall be siz to accommodate the active channel observed at the crossing site.		

TABLE 2B Minimum Bridge Structure Opening for Stream Crossings Choose the drainage area closest to your site drainage area				
Drainage Area (Acres)	Minimum Span Temporary Bridges (FEET) Distance between abutments	Minimum Height Temporary Bridges	Minimum Span Permanent Bridges (FEET) Distance between abutments	Minimum Height Permanent Bridges (FEET) from average streambed elevation to lowest of superstructure
<100	6	OHW	6	2.5
160	7	OHW	7	2.75
200	8	OHW		
320	10	OHW		
640	13	OHW		
960	16	OHW		
1,280	18	OHW		
1,920	21	OHW		
2,560	24	OHW		
3,200	27	OHW		
3,840	29	OHW		
4,480	31	OHW		
5,120	33	OHW		
5,760	34	OHW		
6,400	36	OHW		
Streams with drainage areas of 160 acres or greater are likely to be perennial. Adhere to the VRC Technical Guidance for Identification of Perennial Streams 640 acres = 1 square mile				
** See Below				
*Minimum Height: Low chord of superstructure at or above OHW (Ordinary High Water Mark).				
**AMP 6.5.3 and 6.5.4 State that "Temporary Bridges shall span the entire width of the stream channel." The minimum span for bridges shall be according to table 2B, or shall span the entire width of the stream channel as observed at the crossing site.				

Clean Water Principles

- Disconnect road Stormwater whenever possible, perpendicular flow
- Infiltrate stormwater
 - Slow it down
 - Spread it out
- Stabilize conveyances and turn out ditches or add ditch relief culverts
 - Spread water back out
- Properly size stream crossings



Different Road Types on ANR Lands

- ▶ **Type 1 Roads-** a road that provides recreational and management access to Vermont State Parks, developed Alpine Ski Areas and F+W fishing access areas.
 - ▶ Uses MRGP standards
- ▶ **Type 2 Roads-** gravel surface roads, wide enough and have a suitable gravel surface for a motor grader to grade. The travel lane is greater than 12 feet wide, may be crowned and sloped so water sheds off the surface into ditches or in a distributed manner, or may have a combination of practices to shed water including crowning, broad based dips, or waterbars . Type 2 roads have ditching with ditch relief culverts and permanent stream crossings to manage water outside of the roadway.
- ▶ **Type 3 Roads-** gravel surface but is not easily graded or accessed by a motor grader. The travel lane is typically 12 feet or less in width and has a combination of practices to shed water including crowning, out-slope, in-slope, broad based dips and waterbars. Type 3 roads typically have ditches with cross-drain culverts and permanent stream crossings and can range from being heavily covered in grass to grass-free.
- ▶ **Type 4 Roads-** surface consists of native material and generally utilized during frozen conditions as a winter harvest road and/or designated VAST (Vermont Association of Snow Travelers) trail. The travel lane is not graded by a motor grader and has broad based dips and waterbars to shed water from the roadway. Type 4 roads sometimes have permanent stream crossings removed, but when designated as a VAST trail, permanent crossings occur with more frequency and also has occasional ford crossings.
 - ▶ Type 2,3 and 4 roads use AMP standards

Hydrologically-Connected Road Segments

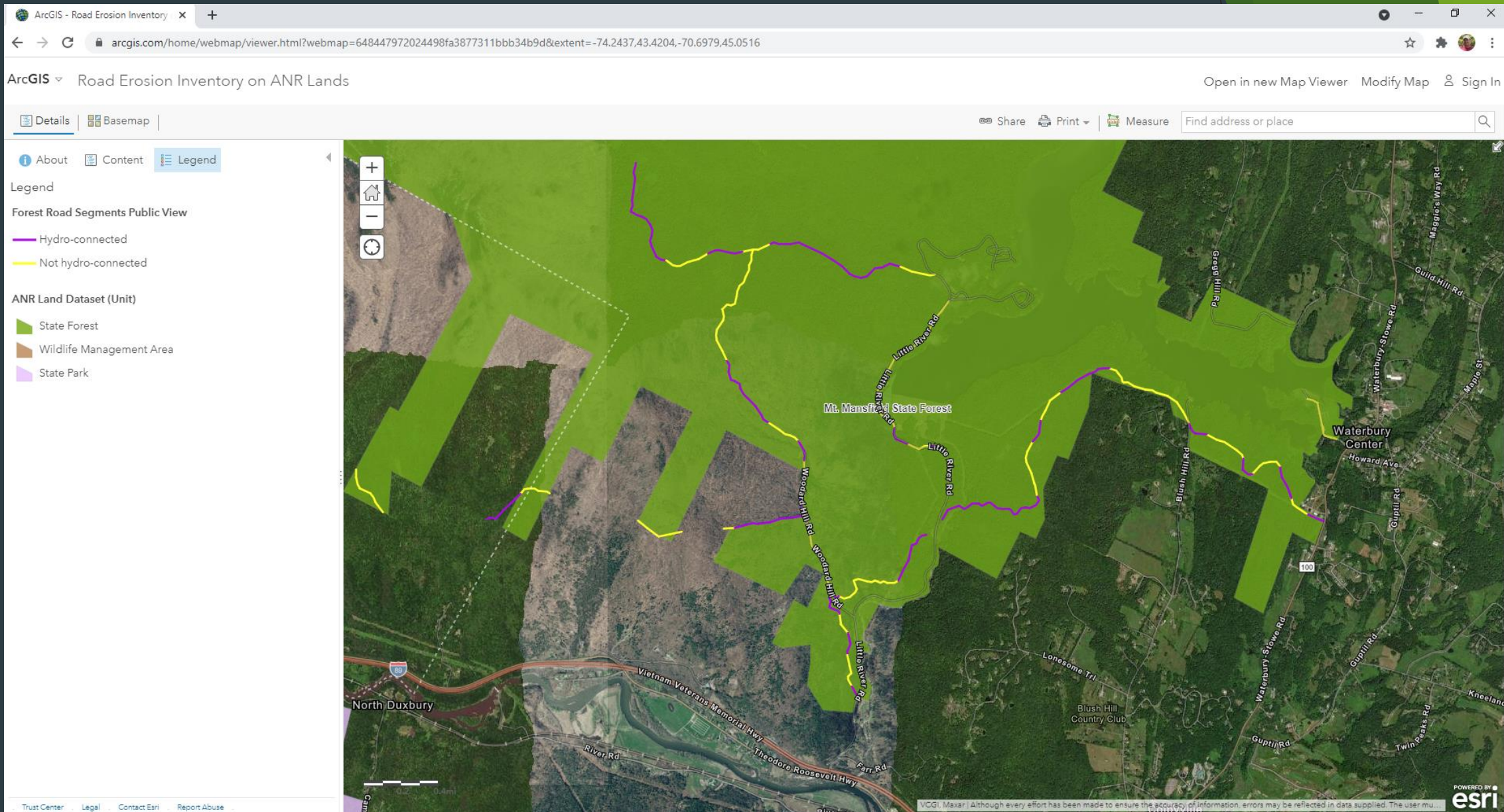
Segment length = 100 Meters

Connected Criteria:

- ▶ Within 100' of a water resource
- ▶ Bisects (crosses) and drains to a water resource
- ▶ The forest road segment is uphill from, and drains to, a segment that bisects a water of the state
- ▶ Connectivity status can be changed during the inventories

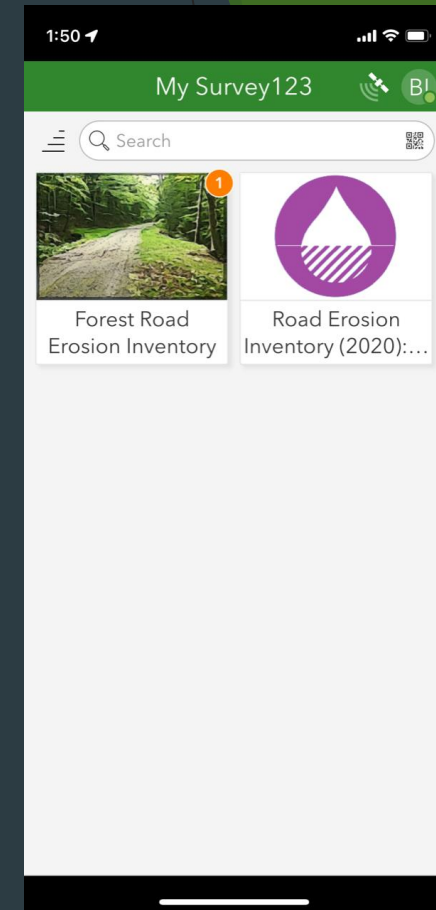
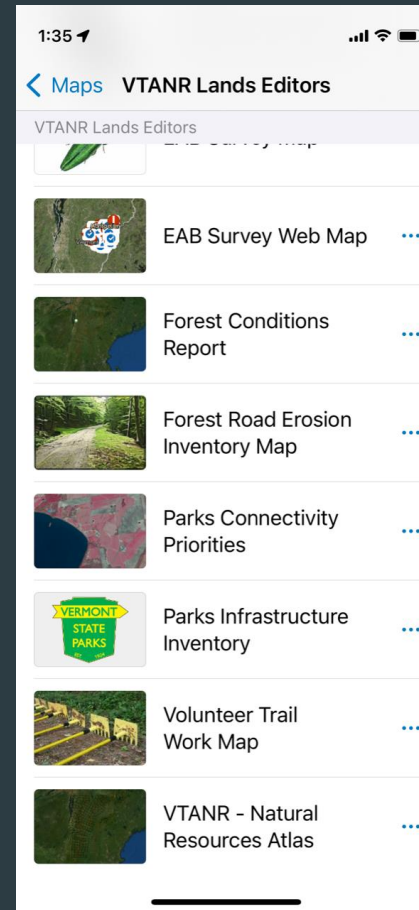
Water Resources:

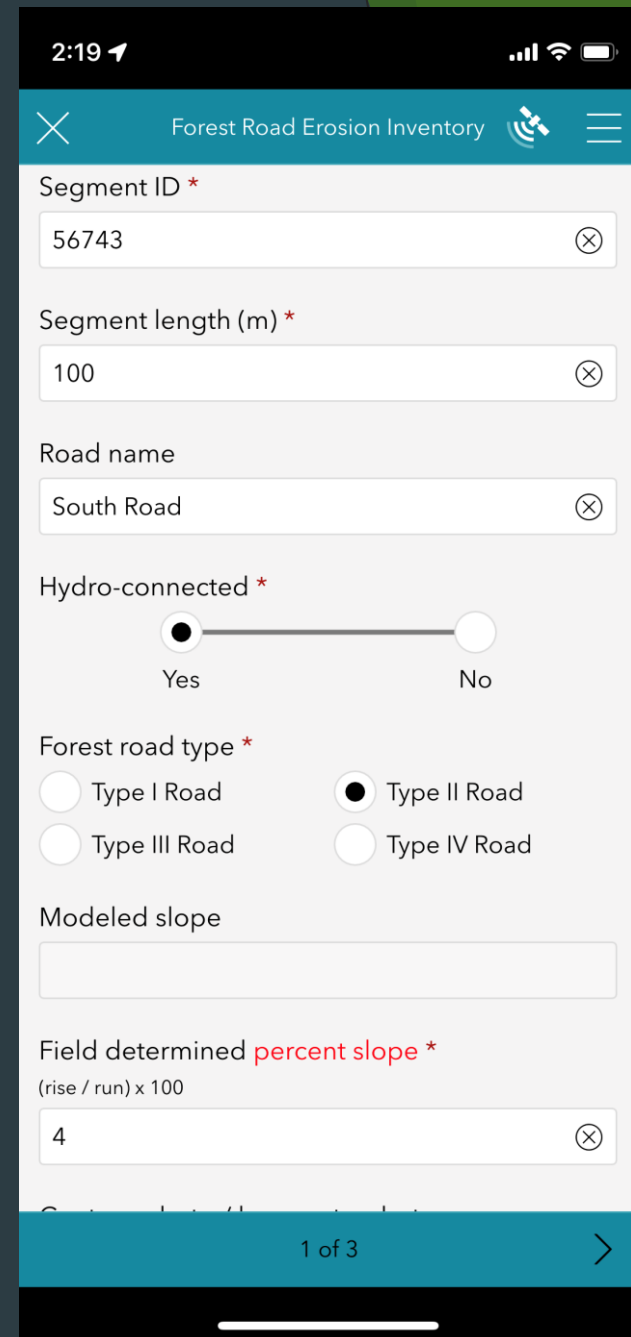
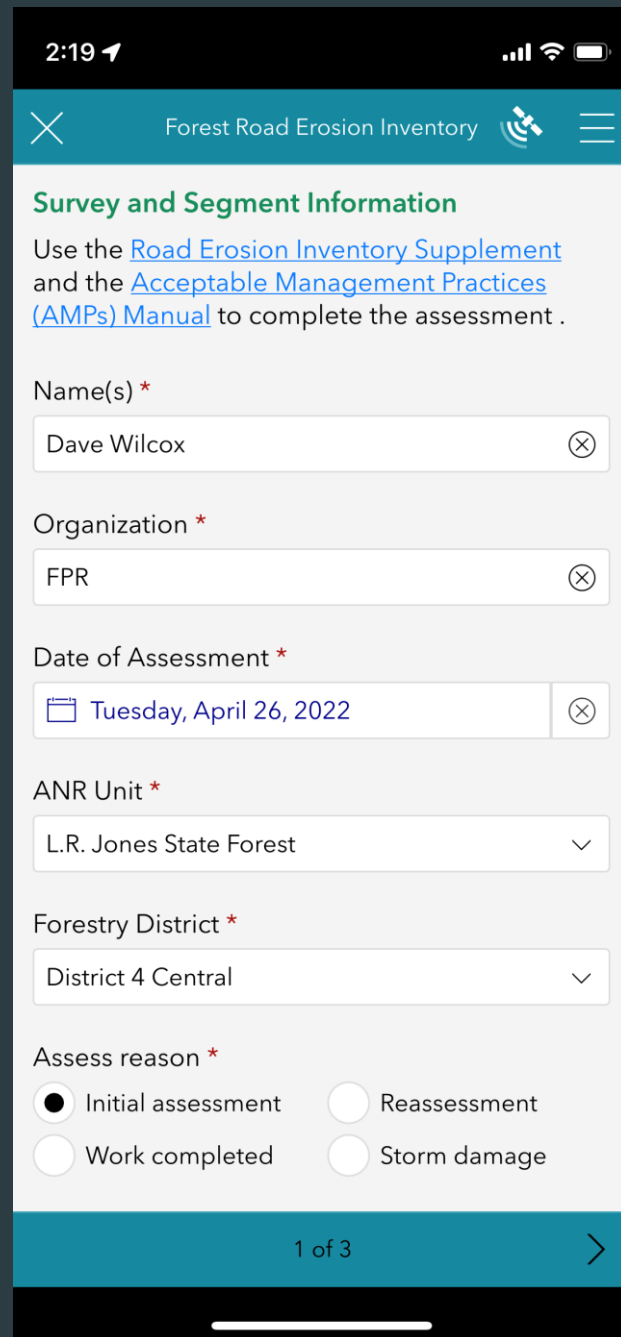
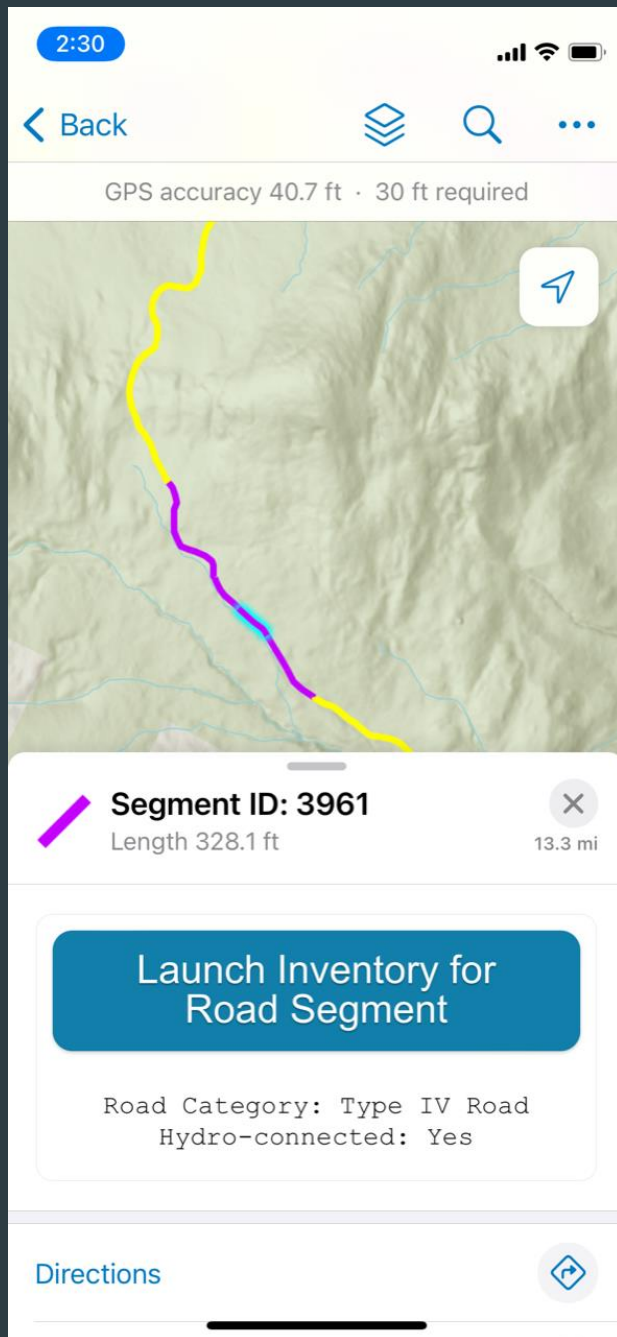
- ▶ Perennial streams
- ▶ Intermittent streams/Defined channel (even if dry)
- ▶ Wetlands
- ▶ Lakes and Ponds



ANR Road Erosion Inventory (REI)

Utilizes Field Maps and Survey 123 to manage the segments and collect segment data.





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Forest Road Erosion Inventory

Type II-IV Forest Roads

Travel Lane/Crown:

A-1: Is 90% of the segment insloped, out-sloped or properly crowned ($\geq 2\%$ crown slope)? *

Yes

No

Not applicable

A-2: Are functioning broad-based dips or waterbars spaced at intervals less than;

300 feet (2-5% field determined slope)?

Answer

*

Yes

No

Not applicable

A-3: What type of erosion is within the travel lane? *

Document: rill erosion $\geq 4'$ long; gully erosion $\geq 1'$ long

Gully erosion (6"+ depth)

Rill erosion (between 1" and 6")

Sheet flow (1" or less) or none

<

2 of 3

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Forest Road Erosion Inventory

Road shoulder/ditch area

B-1: Is 90% of the roadway runoff flowing in a distributed manner and shedding into a vegetated area or drainage ditch that is;

stabilized with vegetation and/or stone (<5% field determined slope)?

Answer

*

Yes

No

B-2: What type of erosion is within the road shoulder or ditch area? *

Document: rill erosion $\geq 4'$ long; gully erosion $\geq 1'$ long

Gully erosion (6"+ depth)

Rill erosion (between 1" and 6")

Sheet flow (1" or less) or none

Notes on segment's drainage

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2 of 3

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Forest Road Erosion Inventory

Drainage Culverts

Inventory cross drainage culverts, culverts used for landings, intersections, side roads and driveways. Not culverts associated with stream crossings.

C-1: Are functioning cross-drainage culverts spaced at intervals less than;

200 feet (5-10% field determined slope)?

Answer

*

Yes

No

Not applicable

C-2: Are all drainage culverts $\geq 15''$ in diameter? *

Yes

No

C-3: What type of erosion is associated with the segment's drainage culverts? *

Gully erosion (6"+ depth)

Rill erosion (between 1" and 6")

Sheet flow (1" or less) or none

Notes on segment's culverts

<

2 of 3

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2:22
Forest Road Erosion Inventory

Stream Crossing and Disconnection

D-1: Are perennial or intermittent stream crossings present in road segment? *

☒ Yes
☐ No

Inventory each perennial and intermittent stream crossing within the segment

Stream Crossings Repeat

D-2: Crossing Type *

Intermittent stream **culvert**

D-3: Is the intermittent stream crossings sized to *active channel* width? *

☐ Yes
☐ No

D-4: Are disconnection practices a minimum of 25' away from top of bank? *

☐ Yes
☐ No

D-5: Is the stream crossing failing or $\geq 75\%$ obstructed? *

☐ Yes
☐ No

2 of 3


2:22
Forest Road Erosion Inventory

Forest Buffers

E-1: Is there recent disturbance in the forest buffer area? Use AMP Table 4 below to determine minimum forest buffer widths. *

Percent Slope of Land Between Skid Trails, Truck Roads or Log Landings and Streams or Other Waters	Width from Top of Bank (Feet Along Surface of Ground Measured Perpendicular to the Stream or Other Waters)
0-10	50
11-20	70
21-30	90
31-40*	110

*Add 20 feet for each additional 10 percent slope



Remember that the buffer distance is measured on each side of the stream. For example, if one side of the stream is 7% slope, the buffer distance on that side is 50 feet. If the other side is 15% slope, the buffer distance on that side is 70 feet. The total forest buffer width at location on the stream is 120 feet.

☒ Yes
☐ No

E-2: Are exposed soils seeded and mulched? *

☐ Yes
☐ No

E-3: What type of erosion is within the segment's forest buffer area? *

2 of 3

2:23

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Forest Road Erosion Inventory

Segment Maintenance and Recommendations

Does the road segment need maintenance or a practice installed? *

Yes

No

Recommended roadway maintenance and practices

select all that apply

☐ Crown road

☐ Grading

☐ Resurface gravel

☐ Install waterbar/
broad-based dip

☐ Install sub-surface
drainage

☐ Lower road
shoulder

☐ Armor shoulder

☐ Other

Recommended ditch maintenance and practices

select all that apply

☐ Install cross-drainage culvert

☐ Add new driveway culvert

☐ Install inlet culvert header

☐ Install outlet culvert header

☐ Line ditch with stone

☐ Line ditch with vegetation

☐ Establish ditching

☐ Ditch cleaning and maintenance

☐ Add new ditch turnout

☐ Add culvert outlet treatment (stone apron)

☐ Establish conveyance zone

☐ Install stone check dams

☐ Add cross drainage/ditch relief waterbar

☐ Other

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3 of 3

✓

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Forest Road Erosion Inventory

☐ Armor shoulder

☐ Other

Recommended ditch maintenance and practices

select all that apply

☐ Install cross-drainage culvert

☐ Add new driveway culvert

☐ Install inlet culvert header

☐ Install outlet culvert header

☐ Line ditch with stone

☐ Line ditch with vegetation

☐ Establish ditching

☐ Ditch cleaning and maintenance

☐ Add new ditch turnout

☐ Add culvert outlet treatment (stone apron)

☐ Establish conveyance zone

☐ Install stone check dams

☐ Add cross drainage/ditch relief waterbar

☐ Other

Recommended crossing maintenance and practices

select all that apply

☐ Replace perennial stream culvert

☐ Replace perennial stream bridge

☐ Replace intermittent stream culvert

☐ Replace intermittent stream bridge

☐ New perennial stream culvert

☐ New perennial stream bridge

☐ New intermittent stream culvert

☐ New intermittent stream bridge

☐ Install perennial stream ford

☐ Install intermittent stream ford

☐ Install perennial stream open crossing

☐ Install intermittent stream open crossing

☐ Install inlet culvert header

☐ Install outlet culvert header

☐ Install sediment control

☐ Install seed and mulch

☐ Other

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3 of 3

✓

2:16

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Forest Road Erosion Inventory

Recommended crossing maintenance and practices

select all that apply

☐ Replace perennial stream culvert

☐ Replace perennial stream bridge

☐ Replace intermittent stream culvert

☐ Replace intermittent stream bridge

☐ New perennial stream culvert

☐ New perennial stream bridge

☐ New intermittent stream culvert

☐ New intermittent stream bridge

☐ Install perennial stream ford

☐ Install intermittent stream ford

☐ Install perennial stream open crossing

☐ Install intermittent stream open crossing

☐ Install inlet culvert header

☐ Install outlet culvert header

☐ Install sediment control

☐ Install seed and mulch

☐ Other

Non-water quality observations

select all that apply

☐ Hazard trees

☐ Roadside mowing

☐ Invasive species

☐ Illegal dumping

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3 of 3

✓

Segment Scoring

Travel lane :

- ▶ Crown is installed on 90% or greater of segment or Water bars/dips in place and none to rill erosion, fully meets, if gully erosion partially meets.
- ▶ Crown not installed on 90% or greater of segment or Water bars/dips not in place and no erosion, Practice fully meets
- ▶ Crown not installed on 90% or greater of segment or Water bars/dips not in place and rill erosion in place, Practice Partially Meets
- ▶ Crown not installed on 90% or greater of segment or water bars/dips not in place and gully erosion in place. Practice Does Not Meet

Shoulder/ditching scoring:

- ▶ Distributed flow or proper ditching based on slope in place present on 90% or more and none to rill erosion present- Practice Fully Meets, if gully erosion partially meets.
- ▶ Distributed flow or ditching practices absent on more than 10% of segment and no erosion present, Practice fully Meets
- ▶ Distributed flow or ditching practices absent on more than 10% of segment and rill erosion present, Practice Partially Meets
- ▶ Distributed flow or ditching practices absent on more than 10% of segment and gully erosion present, Practice Does Not Meet

Drainage culverts scoring:

- ▶ • Drainage culverts properly sized and spaced properly, and none to rill erosion, Fully Meets, if gully erosion is present, Partially meets
- ▶ • Drainage culverts missing and/or undersized and no erosion present, Fully meets.
- ▶ • Drainage culverts missing and/or undersized and rill erosion present, Partially Meets.
- ▶ • Drainage culverts missing and/or undersized and gully erosion present, Does Not Meet

Stream Crossings Scoring:

- ▶ • Crossings properly sized and none to rill erosion present- Fully meets, if presence of inlet sediment deposition and/or outlet scour, or presence of streambed scour at the inlet causing structural undermining - partially meets.
- ▶ • Crossings undersized and no erosion- Fully Meets
- ▶ • Crossings undersized and inlet sediment deposition or inlet scour causing structural undermining - Does not meet
- ▶ • Crossings undersized and outlet streambed scour, channel widening, or perching - Does Not Meet
- ▶ • One or more required disconnection culvert missing- Does Not Meet
- ▶ • Stream crossing failing or more than 75% obstructed - Does not Meet

Forest Buffer Scoring:

- ▶ • Seed and mulch in place and no erosion or rill erosion present on 90% or greater of exposed soil = Fully Meets, if gully erosion present partially meets.
- ▶ • Seed and mulch not installed for greater than 10% of exposed soil and no erosion = Fully meets
- ▶ • Seed and mulch not installed for greater than 10% of exposed soil and rill erosion in place = Partially Meets
- ▶ • Seed and mulch not installed for greater than 10% of exposed soil and gully erosion in place = Does Not Meet

Overall Segment Scoring

- ▶ Fully Meets= all Fully Meets scores
- ▶ Partially Meets= 1 or 2 individual Partially Meets scores
- ▶ Does Not Meet= any Does Not Meet score or 3 or more Partially Meets scores

Water quality Prioritization for Hydrologically Connected Segments

Segment slope	Fully Meets	Partially Meets	Does Not Meet
0-<5%	N/A	Low priority	moderate priority
5-<10%	N/A	Low priority	High priority
10-<20%	N/A	Moderate Priority	Very high priority
>20%	N/A	High Priority	Highest priority

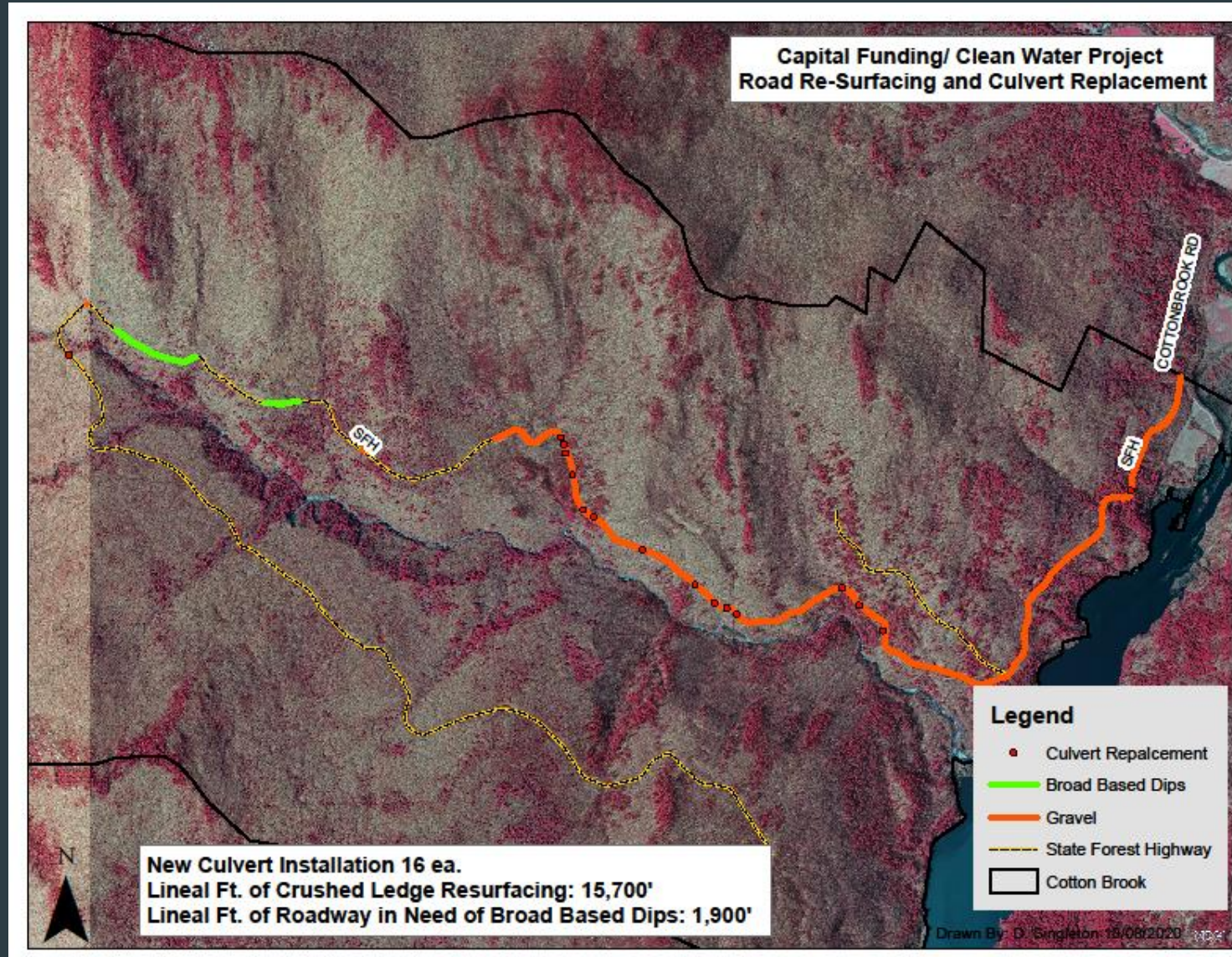
Phosphorus Accounting

- ▶ P-baseload by segment that does not meet standards = 0% reduction
- ▶ Change from Does Not Meet to Partially Meets = 40% load reduction
- ▶ Change from Does Not Meet to Fully Meets = 80% load reduction

Implementation

- ▶ Over the summer of 2020, worked with Jim Ryan and Ryan Knox to develop the REI methodology.
- ▶ During the winter of 2020- 2021, FPR started creating center line data and classifying the roads on Agency Lands.
- ▶ In the spring of 2021, the REI was used to assess several projects that had obvious erosion identified by the District Stewardship Teams.
 - ▶ This was a great way to “ground truth” the system, and FPR identified and laid out several projects.
 - ▶ Over the course of the 2021 field season, FPR completed 7 projects totaling over \$488,000.

Project Location



REI Results

- The road erosion inventory found that many hydrologically connected segment needed some improvement to meet the VT AMP Standards for truck roads.



Corrective Practices Installed

- ▶ Common items included:
 - Ditch relief culverts
 - Ditch disconnection culverts
 - Armoring culvert outlets
 - Correctly sizing structures
 - Re-crowning & grading the road surface & shoulders
 - Installing new road surface material



Ditch Relief & Disconnection

- Ditch relief culverts were installed according to AMP spacing based on road slope.





- ▶ Disconnection culverts were installed to disconnect ditch drainage from directly discharging into waterways.



- Ditches were shortened, turned out and armored.

Structure Sizing

- Undersized structures were removed.
- Replaced with structures sized according to drainage area.



Before



After



Before

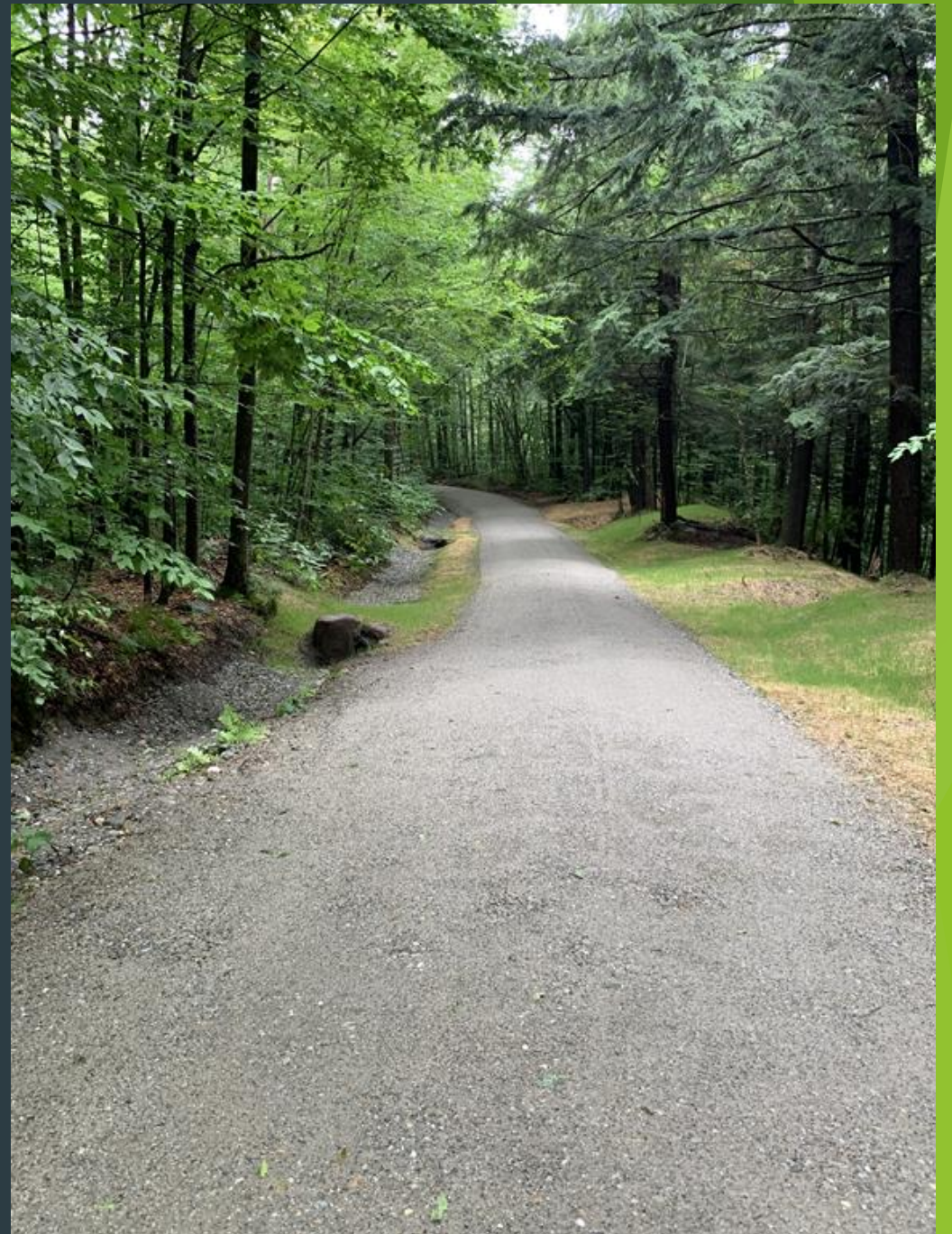


After



Road Surface & Shoulder Improvements

- Improvements were made to roadway to control surface drainage & resiliency.



- The travel lane was properly shimmed and graded to re-establish crown or cross drainage.



- Shoulders were re-graded to establish positive drainage.



- A new wear surface was installed to make the road more resilient and lower maintenance cost.



Project Summary

REI Accomplishments

Feet of road resurfaced	4950
Feet of road crowned/out sloped	4950
Number of waterbars/broad based dips installed	3
Number of turnouts constructed	5
Number of cross drain culverts installed	33
Culvert end treatments completed	33
Feet of ditching completed	100
Feet of ditch stone lined	80
Number of stone check dams installed	0
Feet of sub-surface drainage installed	0
Stream crossings improved	10
Stream crossings permanently removed	0
Feet of existing road brought up to AMP standards	4950
Feet of road "put to bed"	0
Feet of road constructed (to AMP standards)	0
Feet of existing trail brought up to AMP standards	0
Feet of trail "put to bed"	0
Feet of trail constructed (to AMP standards)	0
Other- please describe	0

Project Cost

Equipment	\$65,682.50
Road Material	\$90,772.75
Labor	\$15,215.00
Misc. Cost	\$1,817.28
Culverts	\$13,686.56
Total	\$187,174.09

Next Steps

- ▶ A contractor is slated to start the inventory process of approximately 1/3 of the forest road miles on Agency Land.
- ▶ Road centerline mapping and segmentation is taking place on the remaining miles of forest roads. An RFP will be put out for another inventory contract this spring/Summer.
- ▶ Another 13 projects have been identified by the District Stewardship Teams to be implemented during this field season.
- ▶ Once the first phase of inventory is completed, the next round of implementation projects will come from the REI process.

Special Thanks to:

- ▶ Jim Ryan- DEC Stormwater Program
- ▶ Ryan Knox- ANR IT
- ▶ Pat Ross- River Management Engineer
- ▶ FPR state lands foresters